Clinical Investigations

Secular Trends in the Incidence of Hip Fractures

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Summary. To explore possible changes in proximal femur (hip) fracture incidence over time, an earlier study among Rochester, Minnesota residents for 1928–1977 was updated through 1982. Reanalysis of data demonstrated rising age-adjusted rates for men over this time. Crude rates rose for women as well, but age adjusted rates leveled off in the mid-1950s, as did overall rates, since the majority of hip fractures were in women. Secular trends were primarily due to changes in the incidence of initial hip fractures associated with moderate trauma, the sort usually attributed to osteoporosis. No differences were noted in trends for cervical vs. intertrochanteric femur fractures; and, excluding the low values for 1928–1942, no significant trends were noted for women within various age groups. Our results for women conflict with estimates from a number of other studies, but these differences may provide a basis for hypothesis development.

Key words: Proximal femur (hip) fracture — Incidence — Secular trends — Osteoporosis.

The number of proximal femur (hip) fractures seen each year is expected to rise dramatically [1, 2] as the population ages, even with steady age- and sex-specific incidence rates. However, recent reports from Great Britain [3–6] and Scandinavia [7–9] suggest that incidence rates are rising as well, although there is some disagreement on this point [10–12]. Because hip fractures have such a dramatic impact on the health of the elderly [2] and on the economics of medical care for this group [13], it is important to know whether or not they are increasing more rapidly than can be accounted for by demographic changes alone. This issue is addressed in Rochester, Minnesota, where detailed hip fracture incidence rates are now available for the 55-year period from 1928–1982.

Methods

Population-based epidemiologic research can be conducted in Rochester, Minnesota because the city is isolated from other urban centers, because medical care is virtually self-contained within the community, and because there are relatively few providers. Most orthopedic care, for example, is provided by the Mayo Clinic, which has maintained a common medical record system with its two large affiliated hospitals for nearly 80 years. The Mayo Clinic dossier-type record thus contains both inpatient and outpatient data. The diagnoses and surgical procedures recorded in these records are indexed. The index includes the diagnoses made for outpatients seen in office or clinic consultations, emergency room visits or nursing home care, as well as the diagnoses recorded for hospital inpatients, at autopsy examination or on death certificates [14]. Medical records of the other providers who serve the local population are indexed in the same way and are also retrievable. Thus, the details of almost all of the medical care provided to the residents of Rochester, regardless of the provider, are available for study. The potential value of this data system (the Rochester Epidemiology Project) for population-based studies has been described previously [15].

Using this unique data base, we identified all proximal femur fractures that occurred among Rochester residents during the period 1928–1982. All proximal femur sites were included except the uncommon isolated fractures of the greater or lesser trochanter. Fractures were divided into cervical (neck, intracapsular) and intertrochanteric (extracapsular) types. Subtrochanteric fractures and those more distal on the femur were excluded. The term “hip fracture” is used interchangeably with “proximal femur fracture” as the condition is defined here. Radiographic or autopsy confirmation was obtained for all but 13 (0.8%) fractures, where a clinical diagnosis alone was accepted. Trauma was classified as “severe”—that which could conceivably cause fractures in anyone (e.g., motor vehicle and recreational accidents and falls from heights), or “moderate”—that which would not usually be expected to result in a fracture (mainly falls from a standing height or less).

In calculating incidence rates, the entire population of Rochester was considered to be at risk. The population rose from 18,928 in 1930 to 56,447 in 1980; and the age- and sex-specific person-years (p-y) used as denominators in the incidence rates
were estimated from decennial census data for Rochester, with interpolation between census years as described previously [16]. Incidence rates were directly age- and sex-adjusted, or age-adjusted for comparisons of men and women, to the population structure of United States whites in 1980. Where possible, rates from other studies were adjusted comparably. Other authors sometimes reported rates only for those over 35 years of age or over 50 years; age-specific rates for younger people were assumed to be 0 in such instances. This should have had little effect; in Rochester, for example, only 4.5% of patients were less than 50 years old at the time of fracture and their deletion would have lowered the overall adjusted rate only slightly. Ninety-five percent confidence intervals (95% C.I.) for Rochester rates were estimated from the cumulative Poisson distribution [17]. Changes in age- and sex-specific incidence over time were assessed using least squares regression analysis [19]. However, even this finding vanished when the very low values for 1928–42 were excluded.

**Results**

Over the 55-year period of study, Rochester residents experienced 1701 proximal femur fractures, for an overall age- and sex-adjusted incidence rate of 108.3 per 100,000 p-y (95% C.I., 103.1–113.4). Crude incidence rates for all hip fractures rose steadily between 1928–32 and 1978–82, while age- and sex-adjusted rates rose rapidly from 24.3 per 100,000 p-y in 1928–32 to 105.7 per 100,000 p-y in 1943–47 (Table 1). Adjusted rates then leveled off, however, and the latter figure was not much different (P = 0.51) from the result obtained for 1978–82 (114.8 per 100,000 p-y). The overall trend in adjusted incidence from 1943–47 to 1978–82 was not statistically significantly greater than 0 (slope = 0.12 per 100,000 p-y per year; P = 0.63).

Since secular trends were accounted for by the initial fractures (Table 1), the remainder of the analysis was confined to that group. Age-adjusted incidence rates for initial hip fractures in men rose by 3.3 per 100,000 p-y per year (P < 0.001). Age-adjusted rates in women rose from 6.3 to 156.6 per 100,000 p-y between 1928–32 and 1977–82 (Fig. 1). This was consistent with a linear trend to increased hip fracture incidence of about 1.38 per 100,000 p-y per year (P = 0.001). Age-adjusted rates in women rose from 6.3 to 156.6 per 100,000 p-y between 1928–32 and 1953–57 but then fell to 13.9 per 100,000 p-y in 1977–82. The overall trend for women was nonlinear and could not be assessed in toto. Between 1953–57 and 1978–82, however, there was no significant trend in the adjusted incidence rates (slope = −0.98 per 100,000 p-y per year; P = 0.17).

Secular trends for cervical and intertrochanteric fractures were similar for men and women (Fig. 1). Both sites displayed the characteristic osteoporotic pattern of exponentially increasing rates with age (Fig. 2). In terms of trauma, secular changes were restricted to the fractures associated with moderate trauma (Fig. 1). The age-adjusted incidence of fractures due to more serious trauma showed no clear trend over time and also failed to show the typical age-related incidence pattern seen for moderate trauma fractures (Fig. 3).

When changes in age-specific incidence were examined for moderate trauma fractures, however, no consistent findings were evident (Fig. 4). Male rates increased significantly over time for age groups 65–74 and 75+ years, but changes in younger age groups were not statistically significant. Among women, rates increased significantly only in those aged 75 years and over. However, even this finding vanished when the very low values for 1928–42 were excluded.

**Discussion**

There seems to be general agreement that the crude incidence of proximal femur fractures is rising in conjunction with aging of the underlying population. Superimposed upon this change, it also appears that the age-adjusted incidence of hip fractures is rising in men. This is seen in Rochester and elsewhere (Fig. 5), with but few exceptions [3, 24].

It is less clear what the secular trend in age-adjusted incidence rates among women might be, as substantial variation in both timing and magnitude of change is seen from one study to another (Fig. 6). Rising rates have been seen in most settings [3, 4, 21, 23, 24, 26–28], however, and for women in Göteborg, Sweden [8], the increase was as steep as that seen for Rochester women in the 1930s and 40s. The early rise in Rochester was originally attributed to better case ascertainment associated with the introduction of hip pinning in the mid-1930s [29]. However, given similar observations in Scandinavia [8, 9, 22] at a later date, it is conceivable that this reflects instead the action of some etiologic factor. It may be of interest in this regard that a steep increase in deaths attributable to domestic falls (associated with osteoporotic, mainly hip, fractures) was also seen in England and Wales between 1920 and 1940 [30] prior to initiation of the incidence studies there.

In contrast, Jensen [11] reported no rise in hip-fracture incidence in suburban Copenhagen, Denmark over the period 1971–76 but noted that age-specific rates, especially for those 75 years old and over, were greater than the figures from Malmö 20 years earlier. Likewise, rates rose in Oslo, Norway between 1960 and 1970 [31] but no additional increase was seen in 1977–81 [12]. Hedlund et al. [32] also found rates for Stockholm County, Sweden in 1972–81 that were greater than those reported ear-